COS adsorbents for propylene purification and the lifetime estimate

Chihiro Kojima,[a] Shingo Sakai,[a] Atsushi Okita,[b] Kazunori Honda,[b] Takahiro Yashima[a]*

[a]*Catalysts Research Center, Research & Development Center, JGC Catalysts and Chemicals Ltd., 13-2 Kitaminato-machi Wakamatsu-ku Kitakyushu-shi, Fukuoka, 808-0027, Japan*

[b]*Technology Innovation Center, JGC CORPORATION, 2205 Narita-cho, oarai-machi, Higashiibaraki-gun, Ibaraki, 311-1313, Japan*

**Corresponding author: Fax number +81-93-751-9799, E-mail address yashima.takahiro@jgccc.com*

Abstract

A lifetime simulator of COS adsorbents has been developed in order to investigate adsorption behavior in industrial adsorbent beds via various experiments. By estimating adsorption behavior in industrial plants, it was suggested that the adsorption rate, not adsorption capacity, limited the adsorbent lifetime. Our new product N247 with improved adsorption rate shows a long lifetime and effective use of adsorption capacity.

Keywords: Carbonyl Sulfide, Adsorbents, Lifetime estimate.

1. Introduction

Polypropylene(PP) is one of the most generalized polymer used industrially in packing materials, containers, automobile parts and so on. Polymerization catalysts used for manufacturing PP have extremely high activity and are known to be deactivated by a small amount of impurities (ppb order) [1]. Carbonyl sulfide (COS) is one of the compounds which are difficult to be removed from propylene by distillation, it is necessary to be removed by adsorbents.

Propylene purification processes using adsorbents are carried out at 0 ~ 60 degree C in liquid or gas phase. Since COS concentration in propylene stream depends on the upper process configuration and composition of crude, lifetime estimates should consider the conditions of each industrial plant. Therefore, it is the purpose of this study to establish a method of lifetime estimate to enable use in industrial plants and develop high-performance COS adsorbents.

2. Experimental

Evaluations were conducted by using equipment shown below, to establish a COS adsorption simulator. Initial adsorption rate test was performed in a fixed bed flow type single column unit. A COS adsorbent (1~2g) was loaded into the single column (5.3 mm I.D.), and then simulated feed stock (dissolved ~10 wtppm COS) was circulated through the column. COS concentration in the simulated feed stock was analyzed by GC with sulfur chemiluminescence detector (SCD) at prescribed time intervals from start up, and adsorption rate constant was calculated by the difference of concentration between inlet and outlet of the column. Saturated sulfur adsorption amount was measured by a fixed bed batch type unit. Amount of sulfur in the adsorbents sampled from the unit at prescribed time intervals was analyzed by Carbon and Sulfur analyzer (NDIR : Non Dispersive Infrared).

3. Results and discussion

The properties of new product N247 and existing product N242 are shown in Table 1. N242 and N247 are produced by JGC Catalysts and Chemicals Ltd.(JGC C&C). It is known that COS is chemically adsorbed by the surface of CuO shown as a reaction formula below, both products consist of CuO to trap the sulfur compounds and Alumina carrier.

$$COS + CuO \rightarrow CuS + CO_2$$

Table 1. Product properties used as COS adsorbents.

Products*	Components		Bulk density [g/ml]	Pore volume [ml/g]
	CuO[%]	Carrier		
N247	50	Alumina	0.8	0.29
N242	50	Alumina	1.2	0.11

*Manufactured by JGC C&C

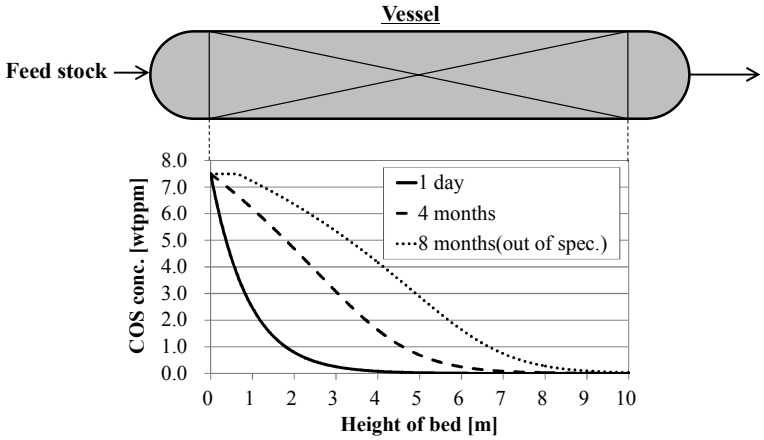

Figure 1. Simulation for N242 lifetime under the model operating condition.
(Specification of outlet COS concentration is 30 wtppb. solid line;1 day, broken line;4 months, dotted line;8 months)

Initial adsorption rate of N242 was measured by a fixed bed flow type single column unit. Although N242 initially had high adsorption rate, the rate decreased with increasing the amount of sulfur adsorption as circulation time proceeds. Adsorption capacity per volume of N242 was measured by a fixed bed batch type unit. From these data, we have developed a COS adsorption simulator to estimate adsorption behavior in industrial adsorbent beds. Result of lifetime estimate is shown in Fig.1. From COS concentration gradient (MTZ : Mass Transfer Zone) at breakthrough in Fig.1(dotted line), COS concentration was constant near the inlet of vessel (height of bed 0 ~ 0.6 m), it is assumed that the adsorbent in this region had been saturated. However, COS concentration decreased in the range from 0.6m to 10m, it is assumed that the vessel had reached its lifetime although the adsorbent in this region remains performance. From this result, it was suggested that a long life can be expected by improving the adsorption rate and effective use of adsorption capacity.

Therefore, N247 improved pore distributions was prepared by using our original molding technologies. Measuring by a fixed bed flow type single column unit, it was found that the adsorption rate of N247 was double compared with that of N242. This result is caused by high pore volume of N247 shown in Table 1, it seems that pore structure of N247 is effective for COS adsorption in liquid phase. Adsorption capacity per volume of N247 measured by a fixed bed batch type unit was equal to that of N242.

From the results of lifetime estimate of N247 and N242 under the model conditions for industrial adsorbent bed, it was shown that N247 had more saturated area in the bed than N242, and the lifetime of N247 is longer than that of N242.

4. Conclusions

To evaluate COS adsorption performance of new product N247 and existing product N242, lifetime estimate was simulated under the model conditions. It was shown that N247 with improved COS adsorption rate compared with N242 is an excellent adsorbent to use effectively adsorption capacity of adsorbents.

References

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